SPECIFICATION AND ASSESSMENT OF ELECTRIC ENERGY STORAGE SYSTEMS BASED ON GENERIC STORAGE LOAD PROFILE

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Introduction

The properties of an Electric Energy Storage System (EESS), such as capacity, maximum charge and discharge power, cycle-life and energetic losses are crucial for its profitability in the field of application. Consequently these properties must be carefully determined during the project planning process. To determine the influences of these properties on the behavior of the system, and hence its profitability in the field of application, the standardized SDA-Methodology has been introduced [1]. It enables the **S**pecification, the **D**esign and the **A**ssessment of different energy storage systems based on detailed performance indicators, e.g. self-consumption and self-supply, and combined performance indicators, such as lifecycle costs or the global-warming potential. This contribution provides a closer look at the specification part of the suggested methodology for an EESS using the example of 'power limiting' for a small industrial plant.

Specification Process

Crucial to the procedure of specification is the analysis of a generic storage load profile, which is synthesized from the applications load profile (see Figure 1). Already during the synthesis a first approach for the operational strategy of the EESS is needed in order to balance the load profile of the EESS, which means that the positive amount of transferred energy is equal to the negative amount. In case of an unbalanced load profile the energy content strives against plus or minus infinity, which means, the EESS would have to generate or dissipate energy in order to fulfill its task.

Mathematically the process of storing energy correlates to the integration of the charge and discharge power over time. Since the energy content of an EESS cannot be less than zero, the energy content at the start of the simulation can dramatically affect the results. To overcome this influence a boundary free EESS must be simulated for the specification process. This is, the energy content can be positive as well as negative. Analyzing the balanced storage profile leads to an efficient specification of the EESS, consisting of its electrical power and capacity. The folowing step of the overall SDA methodology is to design the EESS, which means that a suitable storage technology must be selected and designed in detail.

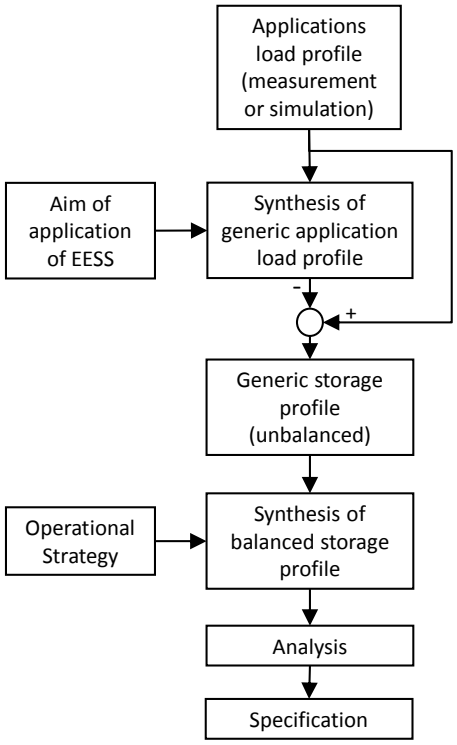

Figure 1: Specification process

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Results and Discussion

Figure 2 shows the resulting residual profiles for the application without EESS, with an unbalanced EESS and a balanced EESS.

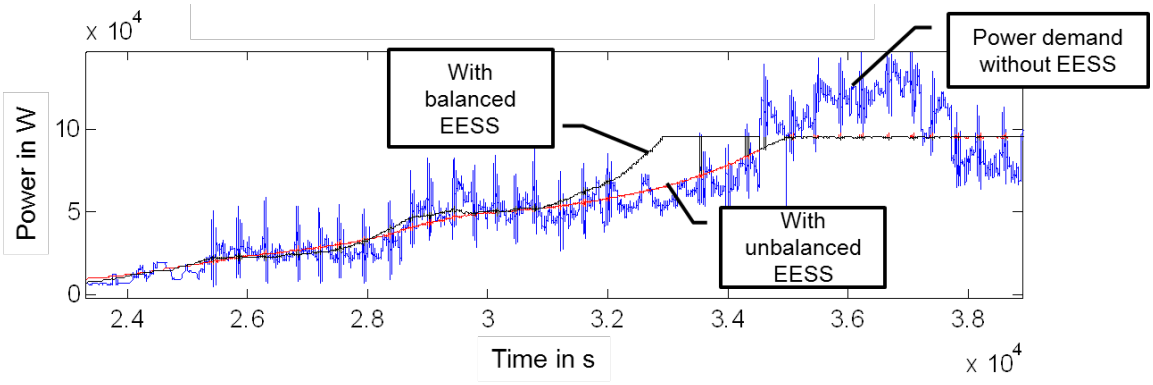

Figure 2: Generic load profile of the industrial application with balanced and unbalanced EESS

The power requirements for the EESS can be determined directly from the frequency distribution of the generic storage load profile (see Figure 3a). Similar to the determination of the power requirements the needed capacity can be determined as the difference between the positive and negative amount of energy (see Figure 3b).

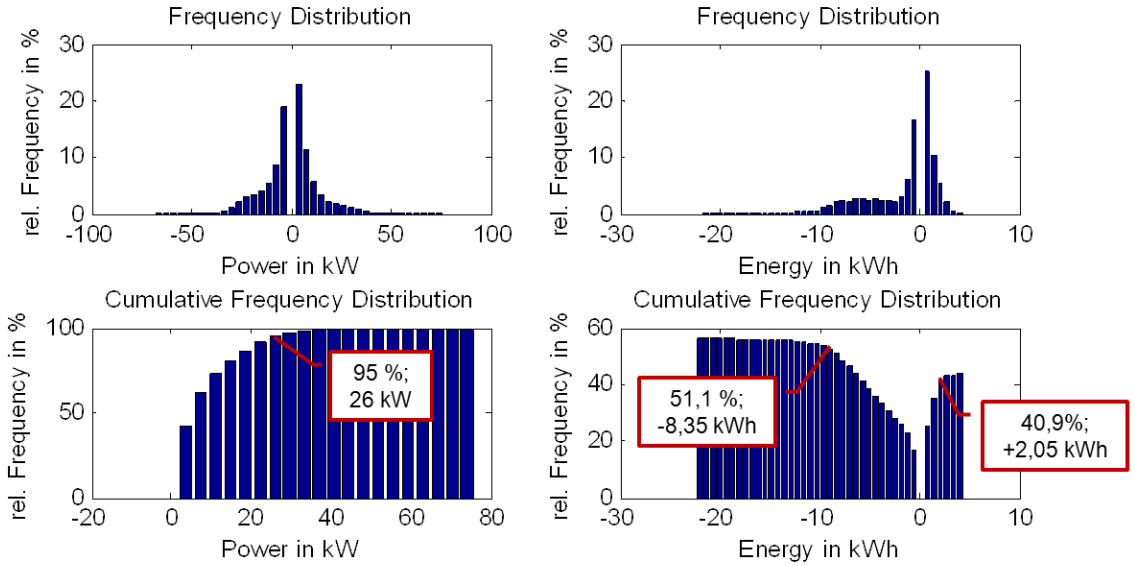

Figure 3a (left) Frequency distribution of the generic power profile, Figure 3b (right) Frequency distribution of energy content of the generic power profile

Furthermore the generic storage load profile also allows for the extrapolation of the number of load changes and cycles over the projected lifetime of the EESS. Moreover the projection of the energetic losses resulting from the generic storage load profile enables the estimation of the energy costs resulting from the operation of the EESS. Together with the asset costs it is possible to calculate the life cycle costs. Different kinds of EESS can be compared on this basis. Accordingly the presented analytical method for the specification of EESS allows for a technologically neutral definition and assessment of the requirements of a projected EESS. It gives a distinct path and makes the specification process reproducible.

References

[1] Schaede, H., Von Ahsen, A., Rinderknecht, S., Schiereck, D. (2013). Electric energy storages – a method for specification, design and assessment. *Int. J. Agile Systems and Management*, Vol. 6, No. 2, 142-163.